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ABSTRACT

This guide describes standard operating job procedures for the grit removal process of wastewater treatment plants. Step-by-step instructions are given for pre-start up inspection, start-up, continuous operation, and shut-down procedures. A description of the equipment used in the process is given. Some theoretical material is presented. (BB)

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SOJP NO 2

GRIT REMOVAL

A GUIDE FOR THE DEVELOPMENT OF

STANDARD OPERATING JOB PROCEDURES

FOR WASTE WATER TREATMENT PLANT UNIT OPERATIONS

DEVELOPED BY
CHARLES COUNTY COMMUNITY COLLEGE
LA PLATA, MARYLAND

GRANT NO 900253
MANPOWER DEVELOPMENT STAFF,
ENVIRONMENTAL PROTECTION AGENCY.

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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A GUIDE FOR DEVELOPING

STANDARD OPERATING JOB PROCEDURES

FOR THE

GRIT REMOVAL

PROCESS

WASTEWATER TREATMENT FACILITY

SOJP NO 2

Developed by Charles County Community College under
a grant with the

Manpower and Training Staff
Office of Water Programs Operations
Environmental Protection Agency

Standard Operating Job Procedures for the Grit Removal Process

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Two years college

Fifteen years sewage treatment operation and related fields.

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B.A. General Science (Biology), 1955, University of Iowa

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Twelve years sewage treatment plant operation and related fields.

Process Grit Removal

1. Operation Objectives

2. Brief Description of Process

1. Operation Objectives:

a. Removal of untreatable sand and grit from wastewater flow for disposal.

b. Elimination of excessive wear on pumps and equipment within the sewage treatment plant from the abrasive action of the sand and grit.

c. Prevention of clogged pipes and facilities.

2. Brief Description of Process:

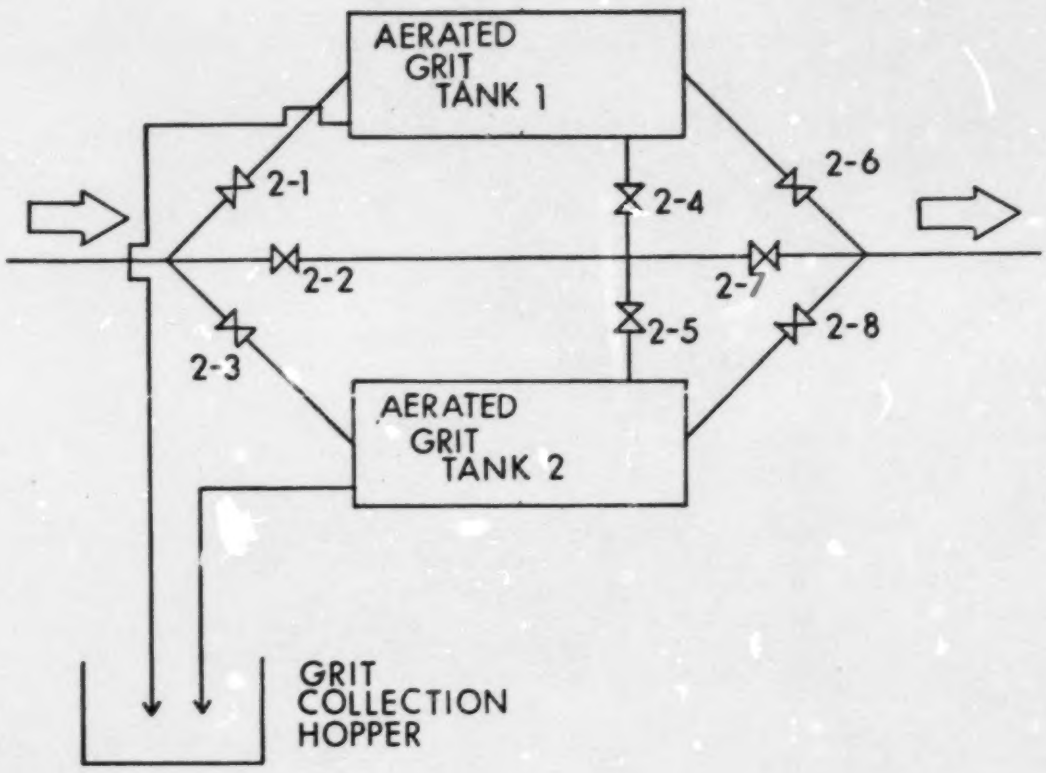
Theoretically, sand and grit should not be discharged to the sanitary sewage collection system, but such materials do enter sewers through manholes, illegal roof spout connections, and combined storm and sanitary sewers.

Sand and grit are removed from the wastewater by reducing the velocity of flow and permitting the heavier sand and grit particles to settle out.

Wastewater enters concrete tank where it is agitated by compressed air in a spiral flow pattern across width of tank. Grit settles to bottom of tank due to its density being greater than water or organic matter. Grit is collected from bottom by buckets moving on chains, rails, and guides. Buckets drop grit into screw conveyor which transfers it to disposal unit.

Process GRIT REMOVAL

Flow Sheet



Process Grit Removal

General Description of Equipment Used in the Process

Process structures consist of two concrete tanks. At least two units are provided in order that one can remain in service while the other is being cleaned. The width of the tanks is approximately equal to the depth and the length is varied to provide a flow detention period of approximately one minute during average flows. The tanks have inlet baffles to distribute flow, and overflow weirs to maintain constant water depth.

Bottom of tank has chambers along length to create induced flow of wastewater. Wastewater flow is induced by rising air released from bottom of tank between longitudinal baffle and wall. Grit is collected by buckets moving on chains to hopper and is removed by screw conveyor which transfers it to disposal unit. Air compressor is positive displacement type with variable speed drive and has pressure indicators, blow-off valves, and check valves. Collector buckets and chains scrape bottom of tank in opposite direction of wastewater flow, dump grit into screw conveyor, then return above water level to effluent end of tank before entering water again. Chains and other parts of collector are supported on neoprene or steel shoes which ride on rails at bottom of tank and guides and tracks out of tank. Drive mechanism is protected by shear pin.

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PROCESS Grit Removal

Prepared by J.A.Deal J. Montgomery Date 1-4-73

Approved by _____

OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
A. PRE-START UP INSPECTION PROCEDURES			
HAZARD WARNING STATEMENT	Hazards of Grit Removal Process are: 1. Mechanical - moving equipment and drive units. 2. Electrical - power supply and controls. 3. Explosive, toxic or asphyxiating gases-collection in structure area and flow conduits. 4. Infection - contact with grit or waste stream or contaminated equipment.		
1. Safety Inspection	1. Check sluice gates.	1. Closed, tagged, not leaking or damaged. It is tagged to prevent other personnel from opening valve while individuals are working inside tank.	XII-2
	2. Diversion channel in operation.		

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	3. Check power supply.	1. Turned off, tagged.	
		2. Control panels to have rubber mat in front on floor.	
		3. Operator not responsible for size or type of power protective equipment.	
	4. Inspect protective shield.	1. In place, not loose or damaged.	
2. Structure Inspection	1. Inspect tank and appurtenances.	1. Effluent weir level.	
		2. Influent baffle in place.	
		3. No cracks in structure. Surfaces not etched excessively.	
3. Equipment Inspection	1. Inspect collector mechanism.	1. All buckets in place, no bolts missing or loose, perpendicular to chains. Drain holes open, sides not bent.	
		2. Shoes in place, not worn excessively.	
		3. All bearings tight and lubricated including underwater type.	IX-1
		4. Sprockets tight, properly aligned (If split type, check bolts).	

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		5. Drive chain or belt not worn and proper tension. Some types of chain must be mounted on sprockets in proper direction. All link pins are to be tight not worn. Provide equal tension both sides.	
		6. Screw conveyor not bent or rubbing on sides. Shaft bearing tight and lubricated.	IX-2
		7. Proper lubrication of gearbox.	IX-2
	4. Air compression and diffusion equipment.	1. Air filters clean and installed.	IX-3
		2. Check valves operable.	
		3. Vari-speed mechanism operable, and not noisy. Gearbox lubed.	V-1 IX-4
		4. Diffusers clean, in place. Pipe fittings and unions tight. Manifold not loose.	
		5. Air blow-off valves operable, not leaking.	V-2
		6. Wooden baffle, smooth, bolts tight, not warped or splintered.	

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
B. START-UP PROCEDURES			
1. Fill tank	1. Open inlet gate tank #1.	1. Observe flow pattern into tank.	
2. Start Equipment	1. Start compressor.	1. Adjust vari-speed to 50%. Motor must be running.	VII-1 I-1
		2. Observe air pressure as tank fills. Should increase air pressure as water depth increases. Blow-off valves should not leak or be functioning. Observe diffusion pattern across tank. Adjust header valves to provide nearly even diffusion. Head of tank should have slightly more air.	
		3. Check piping for leaks. Manual valve to tank #2 must be closed.	IX-2
		4. Adjust vari-drive unit to attain proper flow in aeration tank. If unit "squeals" from belt noise it should not be operated at this speed because it will cause excessive wear on belt and pulleys.	V-3

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	2. Start collecting mechanism.	1. If timer is provided, operate on "manual."	VII-2
	3. Fill tank #2 and start equipment.	1. Follow same procedure in start-up of #1 tank except for starting compressor.	
	4. Observations of unit process: equipment and operation.	1. Collector mechanism should move without jerking motion or squeaking or scraping noises. If any of these conditions are present look for cause.	V-4
		2. Grit being removed by buckets should not have large amounts of organic matter mixed with it.	VI-1
		3. Grit should not be observed passing over effluent weir.	VII-4
		4. Screw conveyor should move grit smoothly, without binding or scraping.	
		5. Buckets should move from guides and rails onto sprockets without flopping or jerking chain.	V-5
	5. Check timer operation.	1. If timer is provided for collector, set switch to "auto" position.	XI-1

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
C. CONTINUOUS	OPERATING PROCEDURES		
1. Check Equipment (2 hour tour)	1. Check control panel lights.		
	2. Check chain condition.	1. Chain wear and adjustment.	V-6
	3. Check unusual noise vibration, heat, lubrication leaks.		
	4. Check air indicators controls.		
2. Check Process (2 hour tour)	1. Check material in buckets.		
	2. Check flow pattern across tank.		
	3. Check waste stream characteristics.		VI-2, VI-3
	4. Check grit in disposal unit.		VIII-1

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
3. Sample and Analysis	1. Grab samples or composite samples as required.	1. To determine quantity and quality of grit.	II-1 III-1 X-1
4. Process Adjustment	1. Alternative adjustments: a. Air pressure b. Diffusion pattern c. Vari-speed drive	1. Use alternative adjustments to control induced flow velocity as necessary to suspend organic material while settling out heavier grit particles.	V-7
5. Abnormal Waste Flow Conditions	1. High plant influent flow from stormwater.	1. Run grit collector continuously and adjust air pressure as required.	
	2. Excessive organic matter.	1. Increase air pressure, note unusual odors, recheck process.	
	3. Low plant influent flow rates.	1. Increase agitation to prevent solids settling. This can be accomplished by increased air pressure or flow augmentation by recirculation. 2. No adjustments are necessary unless grit quality dictates it.	
6. Lubrication and Preventive Maintenance			IX-1 XII-1

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
D. SHUT DOWN PROCEDURES			
1. Stop or divert flow.	1. Open diversion channel.	1. Necessary only if both units must be taken down at same time or if only one unit is available for use.	VII-5
	2. Close flow channel gate.		
2. Go to manual operation.	1. Continue operation of collector and compressor.	1. Air diffusion will keep organic material in suspension.	
3. Empty tank	1. Drain to sump or recycle channel.	1. If pump operation is necessary, see SOJP #13.	
4. Shut down equipment	1. Stop equipment.	1. Lock out and tag switch gear.	
5. Clean tank and equipment	1. Wash down tank and collector.	1. Drain to sump.	
6. Safety items	1. Inspect as in prestart-up.	1. Report data.	XIII-1

TRAINING GUIDE

SECTION	TOPIC
I	Operating Theory
II	Educational Concepts - Mathematics
III	Educational Concepts - Science
IV	Educational Concepts - Communications
V	Process Equipment
VI	Process Flow - Characterization
VII	Process Control
VIII	Abnormal Operations - Trouble Shooting
IX	Maintenance Practices
X	Laboratory Practices
XI	Instrumentation - Automation
XII	Safety Practices
XIII	Records Reports

OPERATING THEORY

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
I-1 [3.2.1.1]	The lifting action of rising air is the operating force in this type of process. By precise control of air and proper baffling the velocity of circulating wastewater can be accurately controlled. The constant motion created by the air tends to wash the grit and carry in suspension the lighter particles, thus allowing organic material to pass over weir with effluent. The flow-through velocity or retention time has relatively little effect on grit removal.	

EDUCATIONAL CONCEPTS -- MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II-1 [C.3.1.1]	Reports of operation usually record quantity of grit as cu.ft/million gal. flow or cu. meter/cu. meter flow. To calculate volume of grit: Area of unit x depth of grit = volume Example Tank bed 6.0 ft. x 8.0 ft. = 48 sq.ft. 48 x 2.34 ft. (depth measured of grit) = 112.32 cu. ft. Express as cu.ft. per total flow (MG) during collecting period (ex. 70 MG) during one week. $\frac{112.32}{70}$ = 1.60 cu.ft./MG flow	

EDUCATION CONCEPTS -- SCIENCE

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
III-1 [C.3.1.1]	The specific gravity of a substance is the ratio of the weight of a given volume of that substance as compared to the weight of the same volume of some other substance taken as a standard, water being used for comparison of solids and liquids and hydrogen or air for gases. In other words, silica sand with a specific gravity of 2.5 is 2.5 times as heavy as water with a specific gravity of 1.0.	

EDUCATIONAL CONCEPTS -- COMMUNICATIONS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-1 [A.3.4.3]	Unit must be in motion to be properly adjusted. If operated at either extreme of speed range, belt may slip excessively and "squeal," which will cause excessive wear.	
V-2 [A.3.4.5]	Purpose of blow-off valves is to protect compressor unit. To operate by wasting air through blow-off valves is an unnecessary waste of power and causes wear on equipment. This is not necessary due to variable speed arrangement of compressor drive. Unit should have check valve to prevent water from being drawn into compressor through manifold if motor is run backwards. Check valve is also necessary to prevent idle unit from running backwards if two compressor units are used.	
V-3 [B.2.1.4]	If vari-drive slips in intermediate speeds the spring-loaded unit is not responding and must be either lubed with dry lubricant or dismantled and cleaned. Unit should be operated through entire speed range once daily to prevent "freeze-up."	
V-4 [B.2.4.1]	Most units have neoprene wear blocks which are not noisy but other things can bind or scrape, usually in dumping chamber. Check sheet metal guards and housing.	
V-5 [B.2.4.5]	A loose chain or improperly adjusted or too short guides and rails can cause weight of buckets to drop and jerk chain as they approach sprockets.	
V-6 [C.1.2.1]	Chain wears at link-pin interface. Excessive tension causes excessive wear. Follow manufacturer's specifications. Support shoes can be rotated to another face as wear occurs. If any interface wears faster than others, examine for cause. Lube drive chain as per manual.	Maintenance Specifications

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
V-7 [C.4.1.1]	Vari-speed drive should not be run continuously at same speed to prevent abnormal wear. Change speed slightly every four hours if possible.	

PROCESS FLOW -- CHARACTERIZATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VI-1 [B.2.4.2]	Clean, well washed grit has appearance of wet coffee grounds. Particle size of grit removed by careful control of air-induced flow of this process will range down to sand so small that it is not readily discernable to eye. The mass of grit may appear to be gray or black due to staining of anaerobic decomposition of organic matter that takes place in extreme bottom of collection system pipes.	
VI-2 [C.2.3]	The waste stream is essentially raw sewage. The general appearance will be the same except that large particles should be screened out.	
VI-3 [C.2.3]	The character of grit will vary with its source. Silica sand has specific gravity of 2.65, crushed limestone 2.8 and coal and cinders 1.5; so it is evident that a large range of materials can be present as seeds, and kernels may also be present depending on how closely process is controlled.	See page 18

PROCESS CONTROL

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VII-1 [B.2.1.1]	Process air diffusion is operated continuously. Volume and pressure are varied manually by 1) changing speed of compressor, 2) throttling valves in headers, 3) wasting to atmosphere. Efficiency of process is not evident to naked eye. Laboratory analysis of fixed total solids should not give results significantly higher than fixed total solids test of primary effluent. Collector may be operated continuously as by timer. Timer should be set to anticipate high flow periods during day and regular intervals at other times. This will save wear on collecting mechanism. Entire unit should be run during storm flow continuously.	
VII-2 [B.2.2.1]	Collector need not be run continuously. Air diffusion is operated continuously. Collector timer can be utilized to coincide with high flow periods (when more grit is scoured from mains) and cycle on intermittent schedule at other times during day.	
VII-3 [B.2.1.2]	The control of spiral flow velocity possible with this process and scrubbing action of air bubbles allow very clean grit to be removed. If organics are present air must be increased.	
VII-4 [B.2.4.3]	If grit is carried with effluent then spiral flow is too violent and air must be reduced.	
VII-5 [D.1.1.1]	Unit can operate over wide range of flow due to its design. One unit may be sufficient, unless flow volume is extremely high.	

ABNORMAL OPERATION -- TROUBLE SHOOTING

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VIII-1 [C.2.4]	Some kinds of organic matter, i.e., seeds with kernels, are heavy enough to be removed with grit and if air is increased to attempt to remove these, grit also will be carried over weir. Observe the kind of matter present. If some particles such as fecal matter, bits of rags, etc., are present, air must be increased to suspend these. Poor grit can also be returned to tank for washing and subsequent disposal.	
	If clay is present do not attempt to adjust air for its removal. The apparent specific gravity of clay would indicate that it can be removed but high surface area to mass ratio affects its suspension and it will not settle.	See page 18
VIII-2 [C.5.3.1]	Low flow periods will not result in poor efficiency because adequate flow velocity necessary to keep organic material in suspension can be maintained by air adjustment.	

MAINTENANCE PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
IX-1 [A.3.1.3] [C.6]	All bearings and gearboxes and electric motors will be lubed as per schedule of plant practice, but underwater bearings which are normally water-lubricated are usually greased when tank is emptied. Usually plugs must be removed and fittings installed to carry out this operation.	Manufacturer's O & M Manual
IX-2 [A.3.3.6] [A.3.3.7]	Unit components such as these are lubed on regular schedules, but should be checked during inspection, especially if any leaks are noticed. Note condition of lubricant, if it is foamy, dirty, emulsified, unusual odors (burnt), unusual colors, etc.	Manufacturer's O & M Manual
IX-3 [A.3.4.1]	Air filters should be cleaned or exchanged depending ontype when suction head loss is at predetermined amount.	Manufacturer's O & M Manual
IX-4 [A.3.4.3]	Vari-drive should be operated once a day through entire speed range to prevent freezing of components, especially in corrosive atmosphere.	Manufacturer's O & M Manual or other PM

LABORATORY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
X-1 [B.2.4.2] [C.3.1.1]	Grab samples of grit should be collected if unusual conditions are apparent such as high organic content. Grit will be dried and ignited to determine total volatile and total fixed solids. Particle sizes as small as 0.20 mm may be removed. Grit should be sampled at least daily. Composite can be made by sampling from different necessary "quartered" to convenient size.	MOP #18, pg. 29 Volatile Solids of Sludge (use same method)
	Quality of grit is determined by amount of volatile matter contained.	MOP #18, pg. 29

INSTRUMENTATION--AUTOMATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XI-1 [B.2.5.1]	Timer stops must be set by experience with particular plant.	See plant flow records and grit quantity records.
XI-2 [B.2.1.3]	Mercury monometers used to measure suction and discharge pressures of compressor should be left in continuous operation.	
	Air safety blow-off is usually weighted sliding column type. Weights must be selected to provide protection to blower. Do not overload or tie down.	Manufacturer's O & M Manual
	Spring-loaded type must be properly adjusted by closing header valve and adjusting to proper relief pressure.	

SAFETY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XII-1 [C.6]	Never attempt to clean, repair, service or adjust moving equipment even though it may be slow moving (this alone may give false sense of security and cause impulsive acts).	
XII-2 [A.1.1.1]	Tags are for your protection and protection of equipment. Give name, date, reason for lock-out.	

RECORDS--REPORTS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XIII-1 [D.6.1.1]	Daily report sheets a. Quantity of grit - cubic feet per MG b. Quality of grit - volatile solids content Monthly report to regulatory agencies Plant preventive maintenance records Plant lubrication records--for all bearings, gearboxes and electric motors.	